SHOULDER- AND/OR NECK-SHAPED CAP

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part application of co-pending international application number PCT/DE 98/03271 filed on 11/10/98 and claiming the priority of DE 19749780 filed 11/11/97 and refiled on 02/06/96 and on 02/18/96 as revision by including the opposition against the German examination report of 05/27/98 and the amendment.
The abbreviations DE and EP denote the German Pat. Application or Document and European Pat. Appl. or Doc., which will be omitted hereinafter.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates generally to enhance the survival chance by restraining the torso and neck of a restrained passenger in co-operation with the seat belt in order to reduce the acceleration-depending loads below the injury-related values, respectively, during the event of

- arbitrary collision of a vehicle, train or aeroplane or
- turbulence-related vibration of an aeroplane.

2. Description of the Related Art:

It is known in the prior art to provide

- a three-point seat belt ((safety belt or lap-shoulder seat belt) consisting of a shoulder belt extending across the torso and of a lap belt extending across the lower part of body in motor vehicle or
- a two-point seat belt acting as lap belt extending across the lower part of body in aeroplane.

In order to formulate in single terminology a generalized definition for the proper term is presented:

"*belt*" for belt webbing or belt web;

"*belts 1.1, 1.2, 1.3 and 1.4*" for members of a seat belt **1a to 1d** in **Figs.** 1, 2, 8, 33;

"*belts 1.2, 1.3 and 1.4*" for members of a three-point belt **1e** to Λ-shapedly restrain the torso **95** and to restrain the lower part of body **96**, shown in **Fig.** 2, 14;

"*floor 6*" for vehicle-, train- or aeroplane floor in **Fig.** 14;

"*real accident*" of a vehicle, train or aeroplane for front-, side-, rear collision or pile up (mass accident) or for train-, aeroplane accident or turbulence-related vibration of a aeroplane;

"*energy absorption*" for absorption and release of impact energy as well as damping the vibration.

"*undamped energy absorption*" for absorption and release of impact energy while the vibration is undamped.

"*energy-absorbing method*" ref. to Chap. V for a method of energy absorption, undamped energy absorption and preserving the clamping and friction forces of master-clamping elements to absorb the total energy F_n in **Fig.** 9 by gradually absorbing subenergy at its level of threshold value ΔF_i with increment i, increasing from 1 to n, in association with the fracture of the sites of predetermined fracture of elements of energy absorbers, thus enhancing the survival chance and ensuring the restraint of both shoulders and of the neck.

The load cases in a real accident are shown in **Fig.** 1, 2, 9. The load cases, forward motion, oscillating movement and features concerning the X-shaped multi-point seat belt to resolve the failure of the present lap belts of aeroplane and three-point belts **1e** of vehicle are described in detail in DE 19749780.

Because both shoulders of torso **95.2** and/or the neck of head **95.1** are not restrained, a passenger, restrained by the present seat belt, is heavily/fatally injured in the following problem cases in the event of a real accident:

1. Forward motion w_V and pitch-accelerations $\ddot{U}_H$- and $\ddot{U}_S$-dependant loads F_{Sy} and F_{Hy} in front collision. In the figure [1], reproduced in **Fig.** 2, the dummy is thrown forward in a 50% Offset Crash Test just at the velocity of 55 km/h;
2. Backward motion w_H and the same loads F_{Sy} and F_{Hy} in rear collision;
3. Rotating accelerations $\ddot{U}_{Sy}$- and $\ddot{U}_{Iy}$-dependant loads F_{Sx} and F_{Ix} in side collision;
4. Load F_{Sz} and/or injury when being detached from the restraint in rollover;
5. Yaw-acceleration $\ddot{O}$-dependant torque T in offset front-, side- and/or rear collision or pile up. In 40% Offset Euro-NCAP Test a German vehicle [2] rotates about the yaw angle O of 80^0, thus increasing the yaw-acceleration-dependant load to such extent that the head of dummy is displaced out of the window.
6. Great energy in indeterminate direction in **Fig.** 1, 2, 9 due to lack of or insufficient energy absorber in pile up or turbulence-related vibration of a aeroplane or due to the loss of height of an aircraft, such as the Boeing 747, of about 300 m in one millisecond at the route Tokyo to Hawaii on Dec. 27, 97; and/or
7. Oscillating movement due to undamped energy absorption. In co-operation with the Tech. University in Graz the Institute for Vehicle Safety in Munich has run a number of Crash Tests [3] to idealize a real rear collision, where the torso **95.2** is driven forward from the backrest **3.2e** after 40 ms, during which the position the head **95.1** remains unchanged. After 100 ms the head is accelerated about the rotating point H in direction w_H. After 130 ms it makes contact with the head rest **3.6**. The maximal pitch-acceleration $\ddot{U}_H$ is achieved. A rebound and a repeated forward motion of the torso occur after 200 ms. Despite the low speed of 8.5 km/h and the acceleration of 2.5 g in Crash Tests of nine different vehicle seats the oscillating movement is verified. Among 22 volunteers one suffered two days from a minor cervical injury and others one to two days from minor pain.

SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to restrain both shoulders and neck in order to minimize the loads F_{Sy}, F_{Hy}, F_{Sx}, F_{Ix} and/or F_{Sz} below the injury-relevant threshold values in the event of a real accident in **Fig.** 1. The features of the claim 1 describe the principle object. The subclaims describe the other objects of the present invention.

Summary of the advantages of the present invention in arbitrary real collision:

I. In order to restrain the torso **95** and absorb energy in a real accident this principle and other objects of the present invention are accomplished by the following features (proposals):
   - shoulder- and/or neck unit **10, 10a to 10f** ref. to Chap. II to restrain both shoulders of torso **95.2** and/or the neck of head **95.1** and to reduce all angles, shown in **Fig.** 1, and all acceleration-dependant loads and load F_{Sz};
   - guide parts of the buckle assemblies ref. to Chap. III in co-operation with the sets of energy absorbers of shoulder- and/or neck unit;
   - energy absorber **10.3, 10.3a, 10.5, 10.5a, 10.5c** ref. to Chap. IV for the purpose of undamped energy absorption;
   - sets of energy absorbers **40e, 40f** ref. to DE 19758597 for the purpose of energy absorption.

II. Owing to the feature of a pair of open caps **10.4, 10.4b**, which are rotatable about the neck, a shoulder- and neck unit **10d, 10e** with/without energy absorber **10.3, 10.3a**; **10.5, 10.5a, 10.5c** is built from a pair of caps **10.2d, 10.2e** and that pair. A shoulder unit can be made of a shoulder- and neck unit **10, 10a to 10c, 10f.** See claim 1.
In contrast to the shoulder unit **10d, 10e** a detachable shoulder- and/or neck unit **10, 10a to 10c, 10f** is provided with a plug-in connection of at least one pair of latch plates **10.1, 10.1b, 10.1f** in **Fig.** 3, 5, 7, 13a to 13c with the respective buckle assemblies **18a to 18n, 19a to 19n** which are
   - not equipped with sets of energy absorbers as in Case II.1 or
   - equipped with sets of energy absorbers as in Case II.2.

In Case II.1 the shoulder- and/or neck unit operates with the present buckle assemblies **18a to 18n, 19a to 19n** ref. to claim 3 and the seat belt, whose buckle assemblies are provided with the sets of energy absorbers ref. to DE 19758597.
In Case II.2 each buckle assembly **18a to 18n, 19a to 19n**, attached in or to the back rest, ref. to claim 31, has the feature of the buckle assembly **4a to 4c**, whose couple member **1.2a, 1.2b, 1.5. 1.6** is provided with the sets of energy absorbers ref. to DE 19758597 A1.

III. The sets of energy absorbers **30, 40, 40** ref. to DE 19758597 are connected to the shoulder- and/or neck unit by
   - the couple members **1.2a, 1.2b, 1.5, 1.6** of the latch plate **10.1, 10.1b, 10.1f** in **Fig.** 7, 13a to 13c or
   - the wires **47e, 47f** of the rotatable unit **10e**.

The design-parameters are denoted with T_Z, T_L, T_S in **Figs.** 13a, 13b. After the projection of the engaging parts **4.10a, 4.10b** of guide piece **4.7a, 4.7b** in the apertures of the housing of buckle assembly **4a, 4b**, in the direction of double arrow, the clamping parts **4.12** snap into the clamping holes **4.13**. In reaction to the movement of the latch plate loaded to the starting threshold value ΔF_1, the clamping pairs **4.12, 4.13** are disengaged from each other. Later on, the buckle assembly moves along the engaging parts about the deflection similar to T_F of strip **65.1** (not drawn) ref. to DE 19758597. When the backrest is unloaded the housing with/without clamping pairs is pulled back by that strip **65.1** in the state of non-deformation. Therefore, T_L must be at least as long as $(T_S + T_F)$. A test may clarify whether the clamping means **4.12, 4.13** are needed. By these means the position of the buckle assembly in backrest or seat cushion is clearly defined. Due to the restriction for the depth T of backrest or of seat cushion in **Fig.** 11 the length T_L of

engaging parts **4.10a, 4.10b** is restricted too, hence, the following countermeasures are required

1. When the buckle assembly is pulled by large load out of the engaging parts,
   - the tie band (catch band) **1.1a, 1.1b** must be guided by the guide piece **4.7a, 4.7b** fastened to the backrest or seat cushion or
   - the tie bands **1.5. 1.6** must be guided by the moveable housing **4.8c**.
2. In order to exploit the depth T the length T_Z of latch plate **10.1, 10.1b, 10.1f** and/or the length T_L of engaging part **4.10a to 4.10c** is increased

IV. The energy of the passenger, restrained by the seat belt **1a to 1e** and shoulder- and/or neck unit **10, 10a to 10f**, and the vibration, both are absorbed and damped by fracture and friction of the following parts:

- pads of predetermined fracture H_{11} to H_{nm} of energy absorber **10.5, 10.5a, 10.5c**;
- pads of predetermined fracture S_{11} to S_{mn} of energy absorber **10.3, 10.3a**;
- spring **10.9** of latch plates **10.1b** serving as energy absorber, having sites of predetermined fracture "s"; and
- clamping elements of the sets of energy absorbers **40e, 40f** of unit **10e** in **Fig.** 1, whose wires **47e, 47f** are provided for the connection with additional sets of energy absorbers **30, 40, 50, 64 to 68** to increase energy absorption.

Serving as cervical collar (neck collar, neck brace in USA) for child and passenger with weak neck-muscle, particularly when suffering from cervical trauma, the neck-shaped cap **10.4a** of unit **10a** has a wider chin-supporting energy absorber **10.5a** in **Fig.** 4 to improve the properties of bracing the head and absorbing energy during the forward motion of passenger.

V. Both frames **29a** of rotatable device **28a** are guided by two pairs of tubes **27.3** of backrest frame **3.4d, 3.4e**, height-adjusted and secured.

A large amount of energy F_n is absorbed by

- a pair of energy absorbers **10.3** or two pairs of energy absorbers **10.3, 10.5** of unit **10e** and
- the following sets of energy absorbers **30, 40, 50** having wires **37, 47, 57**, representing the sets **40e, 40f** having wires **47e, 47f**, tautly, less tautly and/or loosely connected to the unit **10e**.

Injury-irrelevant threshold value is defined by the difference between two forces ΔF_i smaller than the injury-related load. The threshold values may have different magnitudes. For the energy absorption to the starting threshold value ΔF_1, at least one energy absorber **10.3, 10.5** with/without sites of predetermined fracture is responsible. If all three energy absorbers **10.3, 10.5** are insufficient for the energy absorption, the residual energy is absorbed by at least one clamping element (not drawn) **32.x, 42.x, 52.x**. The clamping elements e.g. **42, 42.1 to 42.n** are series connected in **Fig.** 11. Alternately, the clamping element **32.x, 42.x, 52.x** (not drawn), arranged behind the **32.n, 42.n, 52.n**, can be connected to the unit **10e** by a wire **47x** (not drawn). A test can clarify which is the cheapest restraint device.

In the following embodiment at least one energy absorber **10.3, 10.5** is provided for the energy absorption up to the starting threshold value ΔF_1. In excess of the yield strength and/or due to fracture of the sites of predetermined fracture "s" of the clamping elements **32, 32.1 to 32.n, 42, 42.1 to 42.n, 52, 52.1 to 52.n** the energy is released. A new load zone of e.g. ΔF_h - 500 N is defined, in which at least one master-clamping element **32, 42, 52** is pre-tensioned to prevent vibration. When the wires **37, 47, 57** are pulled, the master-clamping element performs the work of deflection and friction, during which the

sites of predetermined fracture of those energy absorbers **10.3, 10.5** are broken, so that the passenger is neither injured nor thrown back. The energy increase of ΔF_2 is dissipated by the fracture of at least one of the next clamping elements **32.1, 42.1, 52.1** and/or the rest of energy absorbers, so that the passenger is neither injured nor thrown back. The energy is reduced gradually, repeatedly and so long to the load level, defined by e.g. ΔF_e - 500 N, in which the clamping elements **32.1 to 32.e, 42.1 to 42.e, 52.1 to 52.e** are broken, the master-clamping elements **32, 42, 52** can't move anymore and at least one master-clamping element **32, 42, 52**, pre-tensioned at ΔF_f - 500 N, at least one clamping element **32,n, 42.n, 52.n** and/or at least one energy absorber **10.3, 10.5** perform(s) work of deflection and friction.

The energy increase of ΔF_g is dissipated by fracture of all master-clamping elements **32, 42, 52** in excess of the yield strength, of all clamping elements **32.1 to 32.n, 42.1 to 42.n, 52.1 to 52.n** and of all energy absorbers, so that the passenger is neither injured nor thrown back. However, it is possible that a remaining energy ΔF_i at i = h must still be absorbed.

Because the total energy is dissipated to a great extent by the energy absorbers of the seat belt ref. to DE 19749780 A1, a fast absorption thereof takes place.

The following features to optimize the work of deflection- and friction characterize the energy absorbers:

- different or progressive friction coefficient (rough surface property) μ_0, μ_1, μ_2, ..., μ_n in order to damp the oscillating movement and to achieve progressive work of friction in **Fig. 10**;
- attachment of a sound-proofing material **83** having friction coefficient μ_0, different or progressive friction coefficient to the contact surface of retaining element **31** and clamping element **32** in **Fig. 10**. The retaining elements **31, 41, 51** and/or contracting clamping elements can be surrounded by sound-proofing material **83** having different friction coefficient. Noise is avoided by the pre-tension of the clamping element on the retaining element, however, the use of sound- proofing materials is highly recommended.
- arbitrary profile for clamping and retaining element. However, manufacturing a round profile is the easiest and cheapest way.

VI. In compliance with user-friendly operation the unit **10d, 10e** is rotatable about the shoulders **95.2** of the restrained torso from the resting position P to the operating position P_1 as well as about the angle Y in **Fig. 1, 8, 14** owing to rotatable device **28, 28a** by

1. manual operation or
2. a motor (driving or medium-loaded unit) **80** (not drawn) activated before driving, in the event of accident or in excess of speed limit ref. to claim 5, or
3. a pyrotechnic-triggering device **81** (not drawn) comprising a collision sensor **81a** ref. to claim 5. In accident a piston device is triggered to activate the rotatable device.

For the purpose of quick storage and removal, the unit **10a to 10c** is inserted into backrest or seat cushion of the seat **3a to 3c** in **Fig. 14** and secured by inserting the pair of latch plates **10.1, 10.1b, 10.1f** therein, and released by pressing the release button **87a to 87c**. Both latch plates of shoulder- and neck-unit **10a** are disengaged from the seat cushion **3.1a** in **Fig. 14** by pressing the release button **87a**. As front portion of that seat cushion the unit **10a** is removed from the cutaway portion (opening) to exploit its space for accommodation of both lower legs of a child sitting on the rear portion thereof.

With regard to the features energy-absorbing method and multi-point seat belts **1a to 1d** or three-point belt **1e** the seat **3a to 3e** can be converted into

a child-seat **85a** by inserting

- the pair of latch plates **10.1f** of unit **10a** into the buckle assemblies **18a / 19a** and
- the latch plates **2, 9, 11, 25** of 11-point seat belt **1a** into the buckle assemblies **4, 7, 8a, 9.1, 18b, 19b**; *or*

a heavy-child-seat **85b** by removing the unit **10b** through pressing the release buttons **87b** and by inserting

- the pair of latch plates **10.1b** of unit **10b** into the buckle assemblies **18b / 19b** and
- the latch plates **2, 9, 11, 25** of 9-point seat belt **1b** into the buckle assemblies **4, 7, 8a, 9.1**; *or*

a safety seat **85c** for an adult by removing the unit **10** through pressing the release buttons **87c** and by inserting

- the pair of latch plates **10.1** of unit **10** into the buckle assemblies **18e / 19e** and
- the latch plates **2, 9, 11** of 7-point seat belt **1c** into the buckle assembly **4** by means of the belt-feeding device **20** ref. to DE 19749780 and the buckle assemblies **8, 9.1**; *or*

a safety seat **85d** for an adult by

- rotating the unit **10d** about both shoulders, when the torso **95** is restrained, by means of the belt-feeding device **20d** ref. to DE 19749780 and
- inserting the latch plates **9, 11** of 7-point seat belt **1d** into the buckle assemblies **8, 9.1**; *or*

a safety seat **85e** for an adult by

- rotating the unit **10e** about both shoulders, when the torso **95** is restrained by three-point belt **1e**.

The pair, drawn with dotted lines, of buckle assemblies **18n / 19n**, arranged to the backrest **3.2e**, shows another possibility for plug-in connection with the insertable unit **10, 10a to 10c, 10f**.

This child-seat **85a** can be converted into a seat-integrated baby-cot **86** by folding the backrest **3.2a** into the resting position.

The efficiency of passenger protection by means of the shoulder- and neck-unit **10, 10a to 10f** significantly depends on its position customized to the torso in regard to the height and/or width of the backrest via

- inserting the pair of latch plates into one of several pairs of buckle assemblies **18.1 / 19.1 to 18.n / 19.n**;
- suitably positioning the unit **10f** along the width of backrest by rotating the bolt **10.7** in threaded connection with the flange **10.12f** of unit **10f**; or
- rotating a rotatable shoulder-unit **10d, 10e** of seat **3d, 3e**, which can be supplemented by a neck-unit, out of the backrest in dotted-line operating position in **Fig. 1, 8**. The height in resting or operating position is adjustable by means of a driving unit (not drawn).

VII. easy and economical elements made by extrusion, depth extrusion, casting, die casting or of spring plate or of spring steel. Thanks to over- or undermeasure contracting or expanding clamping elements, manufactured in the cheapest way by extrusion method, can easily be matched to retaining element. Owing to the property of the great energy absorption by small mass, lighter materials such as aluminium, magnesium (e.g. GD-MgA12) or alloys thereof or carbon/glass fibre-reinforced plastics, used for skis, are recommended for the caps of the unit **10, 10a to 10f**, latch plates **10.1, 10.1b, 10.1f** and parts of the set of energy absorbers.

Preferably, it should be detach the shoulder-shaped energy absorber **10.3, 10.3a** from the deformable cap **10.2, 10.2a to 10.2f** and the neck-shaped energy absorber **10.5, 10.5a, 10.5c** from the deformable cap **10.4, 10.4a to 10.4c, 10.4f** and to fasten via adhesive fastener such as zip-, snap-in-, Velcro fastener. The absorber as well as cap can be made of one- or two pieces.

In order to save costs to meet the demand for passengers, with different neck- and shoulder shapes, a large number of neck- and shoulder-shaped energy absorbers **10.3, 10.3a, 10.5, 10.5a, 10.5c** and a low number of caps are produced.

Furthermore, costs and time can be saved by child-seats **85a, 85b**, baby-cot **86** and safety seat **85c to 85e** in co-operation with

- direct conversion of seats into child-seats. It is not necessary for the worrisome parents to buy and/or carry along child-seat and baby-cot to hotel, airport, railway station and bus stop;
- automatic integration by means of the belt-feeding device **20d** and rotatable unit **10d, 10e**, which is rotated about the shoulder of the restrained upper part of body to the operating position P_1
  1. by a driving unit in accordance with Chap. II or
  2. only in danger, by a conventional trigger means (not drawn) comprising a collision sensor according to claim 6;
- quick adaptation by changing the shoulder-shaped and/or neck-shaped energy absorber and adhesively fastening to the respective caps and
- immediate decision to occupy and reserve the a large number of seats of bus, train or aeroplane by having the list of seats for babies, adults and children in different weight groups and the possibilities to store the units **10a to 10c** in the respective units of seats **3a to 3c** and to detach by pressing the respective release buttons **87a to 87c**.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying tables and drawings with reference to the xyz global coordinate system:

Fig. 1 is a side view of the 7th embodiment of a rotatable shoulder unit **10e** from the resting position P to the operating position P_1 by the 2nd embodiment of a rotatable device **28a**, the 1st embodiment of the sets of energy absorbers **40e, 40f** arranged to backrest frame **3.4d, 3.4e** and the load cases.

Fig. 2 is a perspective view of a restrained dummy, that has been thrown in VW Polo® in 50% offset crash test at the velocity of 55 km/h in reference to the figure [1].

Fig. 3 is a perspective view of the 1st embodiment of shoulder- and neck unit **10** equipped with a set of energy absorbers **10.3, 10.5** and latch plate **10.1**.

Fig. 4 is a schematic, perspective view of the 2nd embodiment of shoulder- and neck units **10a** equipped with wider chin-supporting neck collar **10.4a**, energy absorbers **10.3a, 10.5a** and latch plate **10.1**.

Fig. 5 is a schematic view of the 3rd embodiment of shoulder- and neck units **10b** equipped with energy absorbers **10.3, 10.5, 10.9**.

Fig. 6 is a schematic view of the 4th embodiment of shoulder- and neck units **10c** equipped with energy absorbers.

Fig. 7 is a schematic view of the 5th embodiment of shoulder- and neck units **10f** plug-in connection with buckle assembly **4b**, guide part **4.7b** and couple member **1.2b**.

Fig. 8 is a perspective view of the 6th embodiment of rotatable shoulder unit **10d** from the resting position P to the operating position P_1 by the 1st embodiment of rotatable device **28**.

Fig. 9 illustrates a total load F_n, absorbed by the restraint system associated with the energy-absorbing method, in the event of real accident.

Fig. 10 is a schematic, perspective view of the 1st embodiment of set of energy absorbers **30, 40e, 40f**.

Fig. 11 is a schematic, perspective view of the 1st embodiment of set of energy absorbers **40, 40e, 40f**.

Fig. 11a is a partial-enlarged perspective view of clamping element with sites of predetermined fracture "b" and a stop pin to block the clamping element.

Fig. 12 is a schematic, perspective view of the 1st embodiment of set of energy absorbers **50, 40e, 40f**.

Fig. 13a is a schematic, perspective view of the 1st embodiment of buckle assembly **4a** comprising a guide piece **4.7a**, release cable **4.2**, tie band **1.1a** and coupling member **1.2a**.

Fig. 13b is a schematic, perspective view of the 2nd embodiment of buckle assembly **4b** comprising a guide piece **4.7b**, electrical motor **4.2b**, tie band **1.1b** and coupling member **1.2b**.

Fig. 13c is a cross-sectional view of the 3rd embodiment of buckle assembly **4c** comprising two tie bands **1.5, 1.6** along the line II-II of **Fig.** 13d.

Fig. 13d is a cross-sectional view of buckle assembly **4.8c,** adjustable along the width of the back rest, having two holes to loosely guide two tie bands **1.5, 1.6**.

Fig. 14 is a front view of the safety seats **85a to 85e, 86**, resulting from the integration of the seat belts **1a to 1e**, shoulder units **10, 10a, 10b, 10d, 10e** and seats **3a to 3e**, for passengers with different weights and body proportions.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The method of the present invention capitalizes on the premise that the total energy (magnitude of energy) in **Fig.** 9 is subdivided, at the best, into a number of subenergies which are released in excess of the respective injury-irrelevant values. This will be apparent by formulating all forces in **Fig.** 1 imposed on the torso **95.2** and head **95.1** of the passenger in the event of collision (front-, side-, rear collision and/or rollover) where the energy of two rotating masses of the torso **95.2** and head **95.1** can only be absorbed by the energy-absorbing restraint thereof in conjunction with the energy-absorbing seat belt.

The features are applicable for bus, train, aeroplane and vehicle provided with an arbitrary number of post sections (pillars).

In the 1st to 7th embodiment the shoulder- and/or neck-unit **10, 10a to 10f** in **Figs.** 24 to 32 comprises

- a pair of shoulder-shaped caps **10.2, 10.2a to 10.2f** with the shoulder-shaped energy absorbers **10.3, 10.3a** and/or a neck-shaped cap **10.4, 10.4a to 10.4c, 10.4f** with the neck-shaped energy absorber **10.5, 10.5a, 10.5c** and
- connecting cap **10.11** concerning one-piece cap **10.2a** of the unit **10a**.

Because functional tests and test data regarding stiffness are not available, it is necessary to design a number of units to restrain the upper part of body **95** and to absorb energy.
By connecting the cap **10.11** the unit **10a** in closed form has the greatest stiffness, however by removing that cap the unit **10c** in open form has the greatest permeability to air.
The division into two self-sustaining caps leads to less stiffness and more permeability to air.
This controversy is resolved by a pair of stiff rotatable device **28, 28a** of rotatable unit **10d, 10e** in the 6th or 7th embodiment.

The latch plate **10.1** is pivotally attached to the flange **10.12** of shoulder- and neck-unit **10** by pin **10.6** or by bolt **10.6a** and nut **10.6b**. The adjustment to the shoulder shape is done by rotating the bolt **10.7** in threaded hole of flange **10.12**. Finally that bolt is secured by nut **10.8**.
Due to the closed openings of cap **10.2** and the latch plate **10.1** to loosely guide the belt **1.1** the detachment of belt therefrom to store the cap requires time. Owing to the open aperture **10.14** of cap **10.2b, 10.2c** and open aperture of latch plate **10.1b**, the belt, when strapped over the unit, is loosely locked and guided by quick-release pin **10.10** and released by withdrawal of quick-release pin.

In the 5th embodiment in **Fig.** 7 the latch plate **10.1f** is secured to the flange **10.12f** by pin **10.6**, bolt **10.6a** and nut **10.6b**. By the rotation of bolt **10.6a** in the threaded hole of flange **10.12f**, the cap **10.2f**, can be moved along the width of the backrest.

The outer tube **27.3** of the backrest frame **3.4a** is provided with a plurality of locking slots q, r, s etc. drawn with dotted lines. in **Figs.** 13d. After the pawl **18.10** pre-loaded by spring **18.5** is disengaged from the locking slot r by its movement in the direction of arrow in **Fig.** 13c, the housing **4.8c**, form-locking connected with buckle assembly **4c**, can be moved along both outer tubes **27.3**. The ends of tie bands **1.5, 1.6**, provided for sets of energy absorbers, are fastened together by bracket **1.7**.

In the 5th or 6th embodiment each of both frames of rotatable device **28, 28a** of unit **10d, 10e** consists of two tubes

- **28.1, 28.2**, force-locking connected with the coupling wall **28.3**, and an L-shaped plate **28.4** or
- **41e, 41f**, force-locking connected with the coupling wall **28.3**, and L-shaped, partly laterally closed and partly laterally open plate **28.4a**.

The end of each rotating lever **28.5, 28.5a** is loosely guided between plate **28.4, 28.4a** and coupling wall **28.3**. Both rotating levers are connected to each other by shaft **28.7**. The cap **10.2d, 10.2e** and release cam **28.6, 28.6a** are fastened to the other end of each rotating lever. In resting position each cap is located in the backrest or upper portion of backrest, if necessary, underneath the head rest **3.6a**. If a supporting tube **3.61** is available, the cap recessed about that supporting tube must be reinforced by reinforcing plate **10.13**.
Due to the rotation of both rotating levers **28.5, 28.5a** operated manually or by driving unit **80**, both release cams **28.6, 28.6a** force the blocking levers **28.8, 28.8a**, pre-loaded by springs **28.10, 28.10a**, to release the locking pins **28.12**, pre-loaded by springs **28.13**, and loosely guided in tubes **28.11**, thereby moving into the holes **28.14** and blocking the rotating levers. When blocked, the unit **10d, 10e** mitigates the loads in the event of rollover, yawing and/or turbulence-related vibration. The position of each tube **28.11** at the coupling wall **28.3** is denoted by the hole **28.14**. From the operating position P_1 to the resting position P both rotating levers **28.5, 28.5a** snap in the stop pieces **28.9, 28.9a** and are restrained thereby.
Because the tubes **28.1, 28.2** or **41e, 41f** are guided by auxiliary tubes **71, 72** of backrest frame **3.4d, 3.4e**, the height of the frames is adjusted in the direction of arrow U in **Figs.** 1, 8 by manual operation or by a driving unit e.g. electrical motor **20.5** (not drawn), similar to **4.2b** in **Fig.** 13b. Upon pressing the master release button **84** the electrical motor is activated to move the unit **10d, 10e** back to the resting position.
The long tubes **41e, 41f** act as retaining elements and girders to define both sets of energy absorbers **40e, 40f**, whose wires **47e, 47f** are tightly, less tightly and/or loosely connected with the rotating levers **28.5a** via the stop pieces **28.9a**, serving as deflectors in order to determine the start of energy absorption.
Due to the forward motion of the dotted-line torso **95.2** each dotted-line rotating lever **28.5a** with cap **10.2e** is rotated to the position P_2 through the opening of L-shaped, partly laterally-closed and partly laterally-open plate **28.4a**, during which the deflection- and friction work are performed by the deflection of the dotted-line clamping elements **42e, 42f** along the respective retaining elements **41e, 41f**. The stored energy is released in excess of the yield strength and/or of the threshold values. Clamping elements can arbitrarily be arranged to retaining element **41e, 41f** to increase energy absorption.
The belt **1.1, 1.2** is loosely guided by U-shaped plate **10.15** (like **10.14**) of cap **10.2e** and, if necessary, loosely locked by quick-release pin **10.10** in **Fig.** 5.

In the 1st embodiment the set of energy absorbers **30, 40e, 40f** in **Fig.** 10 comprises a retaining element **31**, master-clamping element **32** and (not drawn) clamping elements **32.1** to **32.n**. After projecting through or into the cylinder-shaped edges **37c1** of master-clamping element **32**, both ends of auxiliary wire **37a1** of wire **37** are secured by clamping two brackets **37b** or both cylinder-shaped ends **37c, 38c** with wires. The inner diameter d_i of clamping element **31** is equal to outer diameter d_i of auxiliary tubes **71, 72**.

In the 2nd embodiment the set of energy absorbers **40, 40e, 40f** in **Fig.** 11, 11a comprises a retaining element **41**, master-clamping element **42** and clamping elements **42.1 to 42.n**. Owing to taut, less taut and/or loose connection of wires **47.1, ..., 47.n** with the clamping elements **42, 42.1, ..., 42.n** to each other, if necessary by occupying another pair of adjusting holes L_1 to L_e, the onset of each clamping element is determinable. Owing to arbitrary connection of wires with arbitrary clamping elements the succession of fracture of the clamping elements is arbitrarily determined. Determinable, too, is the fracture of each clamping element to absorb energy, e.g. by reaming (bulging) the clamping element **42.1, ..., 42.n** in contact with both heads of stop pin or bolt **46.1, ..., 46.n** with both sides of stop element **41.3** or by fracture in excess of the yield strength when increasingly loaded.

In the 3rd embodiment the set of energy absorbers **50, 40e, 40f** in **Fig.** 12 comprises a cone-shaped retaining element **51**, master-clamping element **52** and (not-shown) clamping elements **52.1, .., 52.n** and **53.1, .., 53.n**. Both ends of auxiliary wire **57a1** of wire **57** are secured to a master-clamping element **52** by rivets **57b1**.

The load-deflection area is progressively achieved by the expansion of cone-shaped clamping element **52, .., 52.n, 53, ...,53.n** along

- the cone-shaped retaining element **51** and/or
- the retaining strut **51.1** whose thickness longitudinally increases.

Although the present invention has been described and illustrated in detail, it is clearly understood that the terminology used is intended to describe rather than limit. Many more objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims, the present invention may be practised otherwise than as specifically described and illustrated.

What is claimed:

1. A shoulder unit of a vehicle, train and aeroplane, in which a passenger is restrained by a seat belt (**1a to 1e**), in a real accident, wherein a shoulder unit (**10, 10a t 10f**) is rotatably attached to or inserted into a backrest (**3.2a to 3.2e**) for the purpose of restraining both shoulders of a torso (**95.2**) in a real accident.

2. A shoulder- and neck unit according to claim 1, wherein a shoulder- and neck unit (**10, 10a to 10f**) is defined by a cap (**10.4a, 10.4c**) and a cap (**10.2a, 10.2c**) or by a pair of caps (**10.4, 10.4b**) and a pair of caps (**10.2, 10.2b, 10.2d to 10.2f**) of the shoulder unit (**10, 10a to 10f**) for the purpose of restraining both shoulders of the torso (**95.2**) and the neck of a head (**95.1**) in a real accident.

3. A shoulder- and/or neck unit according to claim 1 or 2, wherein a pair of latch plates (**10.1, 10.1b, 10.1f**) of the shoulder- and/or neck units (**10, 10a to 10c, 10f**) is in plug-in connection with a pair of buckle assemblies (**18a / 19a to 18n / 19n**), which are rigidly attached to a backrest frame (**3.4a to 3.4c, 3.4e**).

4. A shoulder- and/or neck unit according to claim 1 or 2, wherein the shoulder unit (**10d, 10e**) is provided with a rotatable device (**28, 28a**), which, operated manually or by a driving unit (**80**), medium-loaded unit (**80**) or pyrotechnic-triggering device (**81**), is height-adjustable and/or rotatably attached to a backrest frame (**3.4d, 3.4e**).

5. A shoulder- and/or neck unit according to claim 4, wherein the driving unit (**80**) or the pyrotechnical (**81**) piston device rotates the shoulder unit (**10d, 10e**) about both shoulders of the torso (**95.2**) from resting position P to operating position P_1, due to

- touching an existing switch such as light- or tipping switch;
- pressing x-times, e.g. two times, on a master release button (**84**) of the buckle assembly (**9.1**);
- touching a switch, built into the buckle assembly (**9.1**), thus making contact with a cam of the latch plate (**9**) when inserted in the buckle assembly;
- activating of a door switch when the door is closed or of a sensor, installed in the seat, when the passenger sits down;
- excess of a threshold speed; *or*
- determining a real accident or turbulence-related vibration via a sensor (**81a**).

6. A shoulder- and/or neck unit according to at least one of claims 4 and 5, wherein a pair of frames (**29, 29a**) of the rotatable device (**28, 28a**) is moveable along two pairs of auxiliary tubes (**71, 72**) of the backrest frame (**3.4d, 3.4e**).

7. A shoulder- and/or neck unit according to at least one of preceding claims, wherein the shoulder- and/or neck unit

- **(10)** is defined by a pair of caps **(10.2)**, form- and/or force-locking connected with a pair of caps **(10.4)**, and a pair of latch plates **(10.1)**, force-locking connected with both flanges **(10.12)** of the caps **(10.2)** via connecting elements **(10.6, 10.6a, 10.6b, 10.7,10.8)**; *or*
- **(10a)** is defined by a cap **(10.2a)**, form- and/or force-locking connected with the cap **(10.4a)**, and a pair of latch plates **(10.1, 10.1b, 10.1f)**, force-locking connected with the cap **(10.2a)**; *or*
- **(10b)** is defined by a pair of caps **(10.2b)**, form- and/or force-locking connected with a pair of the caps **(10.4b)**, and a pair of latch plates **(10.1b)**, rotatably attached with both flanges **(10.12b)** of caps **(10.2b)** via connecting elements **(10.10)**; *or*
- **(10c)** is defined by a cap **(10.2c)**, form- and/or force-locking connected with a cap **(10.4c)**, and a pair of latch plates **(10.1, 10.1b, 10.1f)**, force-locking connected with both flanges **(10.12c)** of the caps **(10.2c)**; *or*
- **(10d)** is defined by a pair of caps **(10.2d)** force-locking connected with the rotatable device **(28)**; *or*
- **(10e)** is defined by a pair of caps **(10.2e)** force-locking connected with the rotatable device **(28a)**; *or*
- **(10f)** is defined by a pair of caps **(10.2f)**, both flanges **(10.12f)** of which are force-locking connected with the pair of latch plates **(10.1, 10.1b, 10.1f)** by connecting elements **(10.6, 10.6a, 10.6b)**.

8. A shoulder- and neck unit according to claim 7, wherein the shoulder- and neck unit **(10a, 10c)** is made of one piece.

9. A shoulder- and/or neck unit according to at least one of claims 7 to 8, wherein the shoulder- and/or neck unit **(10, 10a to 10f)** is provided with at least one energy absorber **(10.3, 10.3a, 10.5, 10.5a, 10.5c, 10.9)**.

10. A shoulder- and/or neck unit according to at least one of claims 7 to 9, wherein the energy absorber **(10.3, 10.3a, 10.5, 10.5a, 10.5c)** is detachable from the cap **(10.2, 10.2a to 10.2f, 10.4, 10.4a to 10.4c, 10.4f)** and fastenable thereto by adhesive fastener such as zip-, snap-in-, Velcro fastener.

11. A shoulder- and/or neck unit according to at least one of claims 7 to 10, wherein the energy absorber

- **(10.3, 10.3a)** is defined by pads of predetermined fracture S_{11} to S_{mn};
- **(10.5, 10.5a, 10.5c)** is defined by pads of predetermined fracture H_{11} to H_{nm}; *or*
- **(10.9)** of latch plate **(10.1b)** is defined by a spring having sites of predetermined fracture "s".

12. A shoulder- and/or neck unit according to claim 11, wherein the energy absorber **(10.5a)** of neck-shaped cap **(10.4a)** of the neck collar has a wider shape to support the chin.

13. A shoulder- and/or neck unit according to at least one of claims 7 to 12, wherein the cap **(10.2, 10.2a to 10.2f)** and/or the energy absorber **(10.3, 10.3a)** is shoulder-shaped.

14. A shoulder- and/or neck unit according to at least one of claims 7 to 12, wherein the cap **(10.4, 10.4a to 10.4c)** and/or the energy absorber **(10.5, 10.5a, 10.5c)** is neck-shaped.

15. A shoulder- and/or neck unit according to at least one of claims 7 to 14, wherein the shoulder- and/or neck unit **(10, 10a, 10b)** can be mounted onc the backrest **(3.2c)** or seat cushion **(3.1a, 3.1b)** for the purpose of storage and detachable therefrom by pressing a release button **(87a to 87c)**.

16. A shoulder- and neck unit according to at least one of claims 7 to 15, wherein a removable front portion of seat cushion **(3.1a)** serves as a shoulder- and neck unit **(10a)** and the space thereof is exploited to accommodate lower legs of a child sitting on the rear portion thereof.

17. A seat-integrated restraint system according to claim 16, wherein the set of energy absorbers **(30, 40, 50, 40e, 40f)** comprises

a) one or several contracting clamping elements **(32, 32.1 to 32.n, 42, 42.1 to 42.n, 52, 52.1 to 52.n, 42e, 42e.1 to 42e.n, 42f, 42f.1 to 42f.n)** with/without sites of predetermined fracture "s", where the elements, arranged to or in the retaining element **(31, 41, 51, 41e, 41f)**, are tautly, less tautly and/or loosely connected to each other and to the shoulder- and/or neck unit **(10e)** by the respective wires **(37, 37.1 to 37.n, 47, 47.1 to 47.n, 57, 57.1 to 57.n, 47e, 47f)**;
b) at least a pair of stop pins **(46, 46.1 to 46.n)**; and/or
c) at least one stop element **(41.3)**.

18. A shoulder- and/or neck unit according to claim 17, wherein on increase of load a working area with progressive characteristic is achieved by

- expansion of a cone-shaped clamping element **(52, 52.1 to 52.n)** along the cone-shaped retaining element **(51)**;
- expansion of the clamping element **(42, 42.1 to 42.n, 52, 52.1 to 52.n)**, whose edges are in contact with a retaining strut **(41.1, 51.1)** having an increasing thickness;
- reaming an expanding clamping element **(42, 42.1 to 42.n)** upon contact with the heads of stop pin **(46.1 to 46.n)** projected through the retaining element **(41)** or of stop element **(41.3)** fastened to the retaining strut **(41.1)**; *or*
- different friction coefficient μ_0, μ_1, μ_2, ..., μ_n of the contact surface of retaining element and/or of clamping element.

19. A shoulder- and/or neck unit according to claim 18, wherein the friction coefficient of retaining and/or clamping element is determinable by machining the contact surface thereof or by surrounding with a soundproofing material **(83)**.

20. A shoulder- and/or neck unit according to at least one of claims 17 to 19, wherein both struts of the clamping element **(42, 42.1 to 42.n, 52, 52.1 to 52.n)** are provided with several pairs of adjusting holes L_1 to L_e.

21. A shoulder- and/or neck unit according to at least one of claims 17 to 20, wherein both edges **(37c1)** of the clamping elements **(32)** are cylinder-shaped to receive a pair of auxiliary wires **(37a1)** of a wire **(37)** whose ends are secured by clamping either two brackets **(37b)** to the ends of wires **(37a1)** or both cylinder-shaped edges and the wires **(37a1)**.

22. A shoulder- and/or neck unit according to at least one of claims 17 to 21, wherein the clamping element, arranged to the retaining element, is pre-tensioned.

23. A shoulder- and/or neck unit according to at least one of preceding claims, wherein the the belt **(1.1, 1.2)** is loosely guided by
- projecting through a closed aperture of the cap **(10.2)** and of the latch plate **(10.1)**;
- extending over a U-shaped plate **(10.15)** of the cap **(10.2d, 10.2e)**; *or*
- extending over an open aperture **(10.14)** of the cap **(10.2b, 10.2c)** and of the latch plate **(10.1b)**.

24. A shoulder- and/or neck unit according to claim 23, wherein the belt **(1.1, 1.2)** extending over an aperture of the latch plate **(10.1b)** or a U-shaped plate **(10.15)** is loosely locked by a quick-release pin **(10.10)** and released by withdrawal thereof.

25. A shoulder- and/or neck unit according to at least one of claims 7 to 24, wherein the cap **(10.2, 10.2f)** is height- or width-adjustable by rotating the bolt **(10.7, 10.6a)** in the threaded hole of a flange **(10.12, 10.12f)**

26. A shoulder- and/or neck unit according to at least one of preceding claims, wherein a guide piece **(4.7a to 4.7c)** is rigidly arranged to or movable along the backrest frame **(3.4a to 3.4c, 3.4e)**, where
- an engaging part **(4.10c)** or a pair of engaging parts **(4.10a, 4.10b)** thereof is form-locking connected with an aperture or a pair of apertures of a housing of the buckle assembly **(4.8a to 4.8c)** and
- a tie band **(1.1a, 1.1b)** or a pair of tie bands **(1.5, 1.6)** is loosely guided by a hole **(4.5a)**, a pair of holes **(4.5c)** or longitudinal groove **(4.5b)**.

27. A shoulder- and/or neck unit according to at least one of claims 1 to 6 and 26, wherein the buckle assembly **(4c)** comprises
- an engaging part **(4.10c)**, form-locking connected with a housing **(4.8c)**, movable along a pair of outer tubes **(27.3)**;
- a release cable **(4.2)** having a wire **(4.3)**, which, when actuated, withdraws a release button **(84a)** to disengage the connection;
- a leaf spring **(4.11)** and the pair of tie bands **(1.5, 1.6)**, projected through two holes **(4.5c)** of the housing **(4.8c)** and a hole of the buckle assembly **(4c)** and fastened together by a bracket **(1.7)**.

28. A seat-integrated restraint system according to claim 26, wherein the buckle assembly **(4a, 4b)** comprises
- the housing **(4.8a, 4.8b)**, in the apertures of which the pair of engaging parts **(4.10a, 4.10b)** is inserted till both clamping parts **(4.12)** engages with the clamping holes **(4.13)**;
- a release cable **(4.2)** equipped with a wire **(4.3)** or an electrical motor **(4.2b)** having a driving shaft **(4.3b)**, where the part **(4.3, 4.3b)**, when actuated, withdraws a release button **(84a, 84b)** to disconnect the latch plate therefrom; and
- the tie bands **(1.1a, 1.1b)**.

29. A seat-integrated restraint system according to claim 27 or 28, wherein the engaging part **(4.10a, 4.10b)** has a minimum length of T_L to preserve the form-locking connection with the buckle assembly **(4a, 4b)** of length T_S during unloading and loading the energy absorber to the starting threshold value ΔF_1.

30. A shoulder- and/or neck unit according to claim 29, wherein to exploit the whole depth T of the backrest **(3.2a to 3.2c, 3.2e)** the length
- T_Z of the latch plate **(10.1, 10.1b, 10.1f)** and/or
- T_L of the pair of engaging parts **(4.10a, 4.10b)** or of the engaging part **(4.10c)**

is/are prolonged.

31. A shoulder- and/or neck unit according to at least one of preceding claims, wherein the buckle assembly **(18a to 18n, 19a to 19n)** of the backrest **(3.2a to 3.2c, 3.2e)** has the same features of the buckle assembly **(4a to 4c)**.

32. A shoulder- and/or neck unit according to at least one of claims 4 to 24, wherein the rotatable device **(28)** of the shoulder unit **(10d)** comprises
- the pair of frames **(29)**, force-locking connected to each other, where each frame consists of two tubes **(28.1, 28.2)**, connected to each other by a coupling member **(28.3)**, and an L-shaped plate **(28.4)**;
- a pair of rotating levers **(28.5)**, connected to each other by a shaft **(28.7)**, where the end of each lever is loosely guided between a plate **(28.4)** and the coupling member **(28.3)** and the cap **(10.2d)** and a release cam **(28.6)** are fastened to the other end thereof;
- a pair of stop pieces **(28.9)** to retain both rotating levers in resting position; and
- a pair of parts **(28.8, 28.10 to 28.13)**;

where upon the rotation of the rotating levers **(28.5)**, both release cams **(28.6)** force the blocking levers **(28.8)**, pre-loaded by springs **(28.10)**, to release the stop pins **(28.12)**, pre-loaded by springs **(28.13)** and loosely guided in the tubes **(28.11)**, thereby protruding in the holes **(28.14)** to block the rotating levers **(28.5)**.

33. A shoulder- and/or neck unit according to at least one of claims 4 to 24, wherein the rotatable device **(28a)** of the shoulder unit **(10e)** comprises
- the pair of frames **(29a)**, force-locking connected to each other, where each of which consists of two retaining elements **(41e, 41f)**, connected to each other by the coupling member **(28.3)**, and an L-shaped, partly laterally open and partly laterally closed plate **(28.4a)**;
- a pair of rotating levers **(28.5a)**, connected to each other by the shaft **(28.7)**, where the end of each lever is loosely guided between a plate **(28.4a)** and the coupling member **(28.3)** and the cap **(10.2e)** and a release cam **(28.6a)** are fastened to the other end thereof;
- two pairs of sets of energy absorbers **(40e, 40f)**;
- a pair of stop pieces **(28.9a)** to retain the rotating levers in resting position and to deflectively guide the wires **(47e, 47f)** of the sets of energy absorbers **(40e, 40f)**; and
- a pair of parts **(28.8a, 28.10a, 28.11 to 28.13)**;

where upon the rotation of the rotating levers **(28.5a)**, both release cams **(28.6a)** force the blocking levers **(28.8a)**, pre-loaded by springs **(28.10a)**, to release the stop pins **(28.12)**, pre-loaded by springs **(28.13)** and loosely guided in the tubes **(28.11)**, thereby protruding in the holes **(28.14)**
- to block the rotating levers **(28.5a)** only in one rotating direction,
- but in the other rotating direction the rotating levers rotate in response to forward motion of passenger through the opening of the plates **(28.4a)**.

34. A shoulder- and/or neck unit according to at least one of preceding claims, wherein the cap **(10.2d, 10.2e)** recessed about the supporting tube **(3.61)** of the head rest **(3.6)** is reinforced by a reinforcing plate **(10.13)**.

35. A shoulder- and/or neck unit according to at least one of preceding claims, wherein upon pressing a master release button **(84)** of the buckle assembly **(9.1)** the latch plates **(9, 11, 25)** are disengaged from the buckle assemblies **(7, 8, 8a, 9.1)** and

- the other latch plates **(2, 10.1, 10.1b, 10.1f)** are disengaged from the buckle assemblies **(4, 18a to 18n, 19a to 19n)**; *or*
- the rotatable device **(28, 28a)** and a belt-feeding device **(20, 20d)** are activated to move back the unit **(10d, 10e)** and belt **(1.1, 1.1d)** from operating position to resting position.

36. A shoulder- and/or neck unit according to at least one of claims 1 to 34, wherein upon pressing a master release button **(84o)**, arranged to the seat cushion **(3.1a to 3.1e)**,

- the latch plates **(10.1, 10.1b, 10.1f)** are disengaged from the buckle assemblies **(18a / 19a to 18n / 19n)** and
- the rotatable device **(28, 28a)** is activated to move back the unit **(10d, 10e)** from operating position to resting position.

37. A seat-integrated restraint system according to at least one of preceding claims, characterized by use of metal, compound material, glass fibre reinforced material or non-metal material for material of tie band, coupling members, guide piece, energy absorber, the parts of set of energy absorbers and of the shoulder- and neck-unit.

ABSTRACT

Failure of the present restraint systems is substantiated by severe/fatal injuries in the event of real accident of a vehicle, train or turbulence-related vibration of an aeroplane, e.g. upon the loss of 300 m height within milliseconds. The pitch-, yaw- and lateral acceleration-dependant loads are reduced and the oscillating movement are damped by

- shoulder unit **(10, 10e)** to restrain both shoulders of torso **(95.2)** and the neck of head **(95.1)**;
- sets of energy absorbers **(10.5, 40e, 40f, 30, 40, 50)** to absorb energy;
- exploitation of the space in the seat- and backrest frame to accommodate the sets of energy absorbers and rotatable device **(28a)**;
- guide piece to connect the sets of energy absorbers with the unit **(10, 10e)**;
- energy-absorbing method to gradually absorb the subenergies, resulting from the subdivision of the total energy F_n, at the respective injury-irrelevant threshold values ΔF_i upon damping the vibration.

For the purpose of quick-release in compliance with user-friendly operation and quick-rescue of passenger the master release button of buckle assembly is pressed

- to release all latch plates from buckle assemblies and/or
- to move back the unit **(10e)** to resting position.

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[3] Institut für Fahrzeugsicherheit zu Heft Nr. 9609 "Neck Injuries in Car Accidents...";